REPORT ON WATER QUALITY IN BELMONT LAKE

recreational lakes program

1972

Ministry
of the
Environment
Ontario

REPORT ON WATER QUALITY

in

BELMONT LAKE

1972

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PREFACE

The Province of Ontario contains many thousands of beautiful small inland lakes which are most attractive for recreational use. Lakes close to urban areas and accessible by road often receive heavy use in terms of cottage development, camp sites, trailer parks and picnic areas.

A heavy influx of people may subject a lake and it's surrounding environment to great stress. In many cases, developments are carried out on attractive lakes only to find that when this is complete the lake qualities which were initially so appealing have been damaged. The appearance of the shoreline can be marred by construction, fishing ruined by over harvesting or the growth and decay of excessive amounts of algae and weeds. Motor boats introduce noise and petroleum pollution. Inadequate disposal of human wastes can place a great stress on the lake environment.

The accepted custom of having "a place at the lake" continues to apply pressure for more development, giving rise to an even greater expansion of problems.

The Ontario Ministry of the Environment is attempting to bring some of these stress factors under control with a variety of programs. The cottage pollution control program was initiated in 1967 and was expanded in 1970 in order to solve the cottage waste disposal problem in recreational lakes. There are three on-going studies carried out by the Ministry:

1. Evaluation of existing waste disposal systems and enforcement of repairs to those found to be unsatisfactory;

2. Research to improve the knowledge of septic tank operation and effects in shallow soil areas and evaluation of alternative methods of private waste disposal;

3. Evaluation of present water quality in a number of recreational lakes. A totally undeveloped lake near Huntsville was studied in 1972, in order to obtain more information about natural water quality conditions within a Precambrian Lake, which would assist in defining any unnatural conditions encountered in the developed lakes surveyed.

This report on Belmont Lake is one of a series dealing with the water quality aspects of the recreational lakes studied in 1972. As well as defining the present status of water quality in the lakes, the data are meant to provide an historical reference for comparison of conditions at any future time.

SUMMARY

In 1972, a study to evaluate water quality in Belmont Lake was carried out by measuring chemical, biological and bacteriological parameters on five successive days in each of June, August and September.

Belmont Lake is located on the Crowe River in the County of Peterborough, Township of Belmont, and lies within the Precambrian Shield. The area is characterized by rolling hills and shallow overburden covering the bedrock to a depth less than the 1.5 meters (5 feet) required by the Ministry of the Environment for the installation of standard subsurface septic tank systems. Rocky outcrops dominate most of the shoreline.

Belmont Lake was found to have good bacteriological water quality and was well within the contact recreational use criteria, particularly during the August survey. Two minor pollution sources were noted at the deltas of the North and the Crowe rivers.

The waters of the main body of the lake were of good chemical quality and were closely similar to the Crowe River. A bottom layer of water devoid of oxygen was present in the deepest portion of the lake for more than a month, and oxygen deficiencies were observed even at moderate depths in late August, which would render these depths unsuitable for sensitive fish such as trout. Phosphorus, chlorophyll and Secchi Disc results indicated the lake water generally was of low fertility.

PURPOSE OF THE SURVEYS

The surveys were designed, and tests selected, in order to evaluate the present conditions in the lakes with respect to:

-concentration of bacteria

-plant nutrients and algae

-water quality with depth

-inventory of shoreline development

As a result of human activity in the recreational lake environment, some wastes may reach the lake itself and this can lead to either or both of two major types of water quality impairment, microbial contamination and excessive growths of algae and aquatic plants. The two problems can result from a common or different source of pollution, but the consequences of each are quite different.

Microbial contamination by raw or inadequately treated sewage does not significantly change the appearance of the water but poses an immediate public health hazard if the water is used for drinking or swimming. This type of pollution can be remedied by preventing wastes from reaching the lake and water quality will return to satisfactory conditions since most disease causing bacteria do not persist in the lake.

Nutrient enrichment, or eutrophication, results from the addition of plant fertilizers which occur naturally and are also present in virtually all forms of raw or treated human wastes. High concentrations of these fertilizers (plant nutrients), mainly nitrogen and phosphorus, support extensive growths of rooted aquatic plants and of microscopic free-floating plants called algae. Eutrophication greatly affects the lake appearance but generally does not pose a health hazard. Problems due to nutrient enrichment are generally long lasting and may become irreversible.

Changes in water temperature, dissolved oxygen and quality with depth are very important characteristics of a lake and were examined in the surveys.

Aquatic weed beds provide shelter and food for many kinds of fish. Too much growth is undesirable since it can upset the oxygen balance in the lake and can interfere with recreational uses of the lake.

DESIGN OF THE SURVEYS

Timing

Five day bacteriological, chemical and biological surveys were carried out from June 25 to 29, from August 27 to 31 and from September 19 to 23.

A proper estimation of the bacterial population requires several measurements over a period of time which can then be averaged as a geometric mean. Measurements over 5 consecutive days at each station are regarded as the minimum number which will give reliable bacterial data.

Chemical samples were collected on the first and last days of the surveys at inlet and outlet stations and at the mid-lake stations. Chlorophyll samples were collected each day at the inlet and mid-lake stations.

Selection of Sample Locations

Thirty-nine bacteriological samples sites were established over the whole lake (Figure 1). Chemical samples were collected at the two inlet stations, the outlet station and at three mid-lake stations. In addition to these surface samples chemical and bacteriological samples were taken from the bottom water at the mid-lake stations.

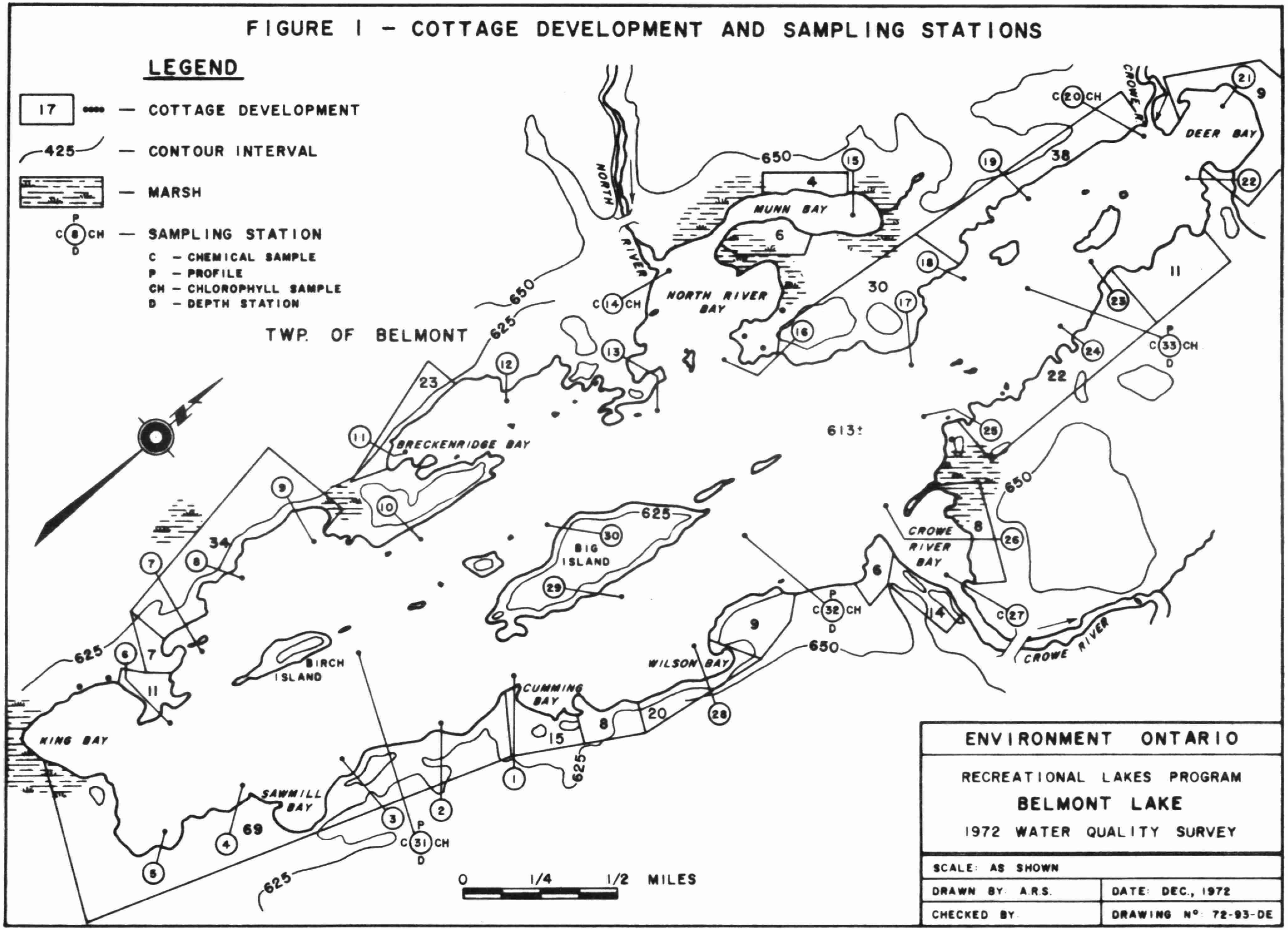


FIGURE 1 – COTTAGE DEVELOPMENT AND SAMPLING STATIONS

Field Tests

The variation in temperature and dissolved oxygen values with depth were measured at the three deep water stations with an electronic probe lowered into the lake and water clarity was measured with a Secchi disc, (Figure 2). The pH and conductivity of the samples were measured in the field.

Bacteriological Tests

Three groups of bacteria were determined on each sample: total coliforms, fecal coliforms, fecal streptococci. These organisms are used as "indicators" of fecal contamination. Many diseases common to man can be transmitted by feces, consequently, the probability of occurrence of these diseases is usually highest in areas where the water is contaminated. The total coliforms, fecal coliforms and fecal streptococci organisms are all indigenous to man and other warm blooded animals and are found in the colon and feces in tremendous numbers. These indicator organisms in the water denote the presence of fecal contamination and hence the risk of disease causing organisms.

Standard plate count (SPC) determinations were made on some mid-lake stations in order to determine densities of some natural water bacteria. The SPC media will only support the growth of those organisms that don't require special nutrients, oxygen requirements and/or incubation temperatures. The SPC is used as a measure of general bacterial activity.

Chemical Tests

Hardness, alkalinity, chloride, iron and conductivity were measured in order to define the mineral composition of the water. The types of plants and animals which thrive, effects of toxic materials and suitability of the lake for various management techniques depend on the mineral content.

The "Secchi Disc Reading" is obtained by averaging the depth at which a 23cm (9") dia. black and white plate, lowered into the lake just disappears from view and the depth where it reappears as it is pulled up.

Most of the free-floating algae are suspended in the illuminated region between the lake surface and 2 times the Secchi disc reading.

Clear, algae-free lake: Secchi disc readings tend to be greater than 3m (9 feet).

Turbid or algae-rich lake: Secchi disc readings tend to be less than 3m (9 feet).

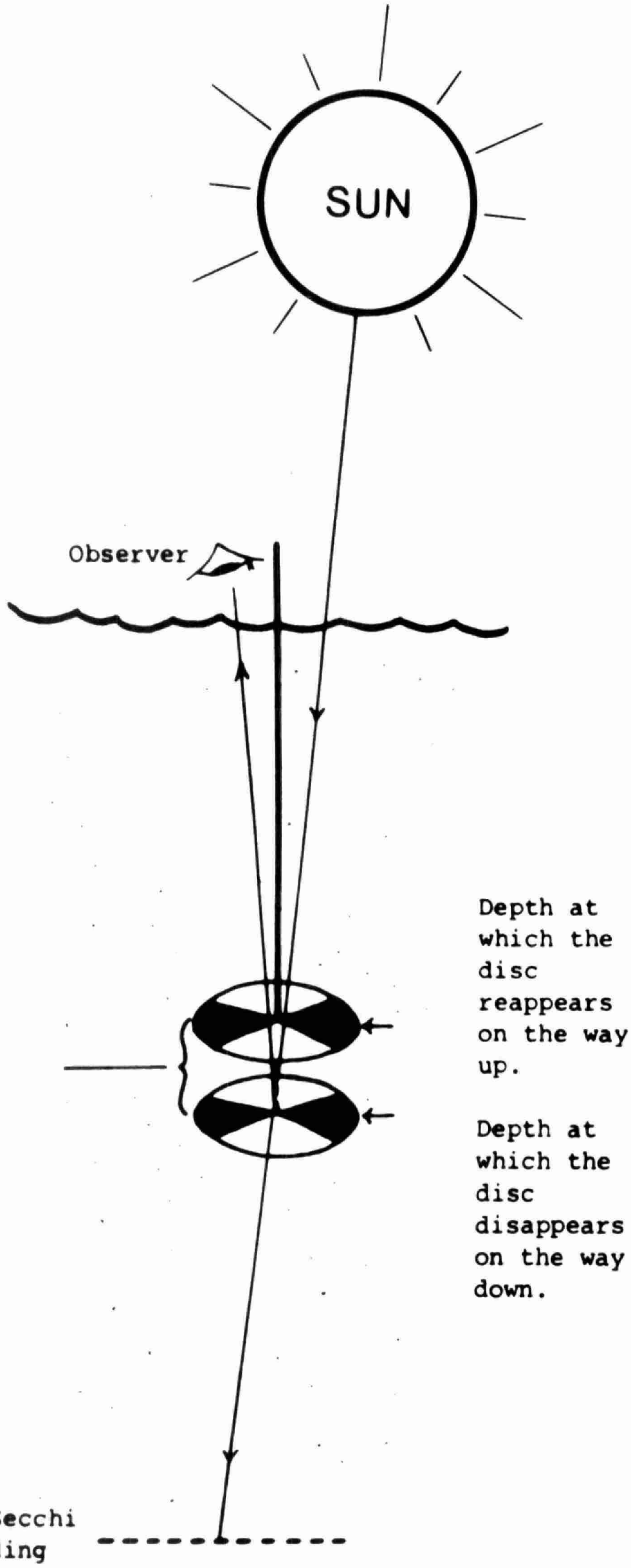


FIGURE 2: USE OF SECCHI DISC TO DETERMINE WATER CLARITY

Total and soluble phosphorus were measured in the inlet and bottom water samples while total phosphorus only was measured in the mid-lake and outlet surface samples. Soluble phosphorus concentrations are used mainly to substantiate various interpretations of the total phosphorus concentrations.

The total Kjeldahl nitrogen is essentially the amount of nitrogen contained in organic material. It was measured in all of the chemical samples. The soluble forms of nitrogen, ammonia, nitrite and nitrate were measured in the inlet and bottom water samples. They are particularly important in bottom waters since nitrogen may be regenerated from decaying organic matter in these forms.

Chlorophyll a concentrations are an indication of the amount of algae in the water. The live algae are confined mainly to the lighted surface waters which extend down to a depth of about twice the Secchi disc reading. The chlorophyll samples were collected by raising the sample bottle through the depth of this illuminated zone as it filled. The sample was then representative of the average number of algae through the illuminated depth of the surface waters.

DESCRIPTION OF BELMONT LAKE AREA

Lake and Soil Characteristics

Belmont Lake is located in Belmont Township, Peterborough County and is approximately 8.1 kilometers (5 miles) northeast of the Village of Havelock.

Generally, the lake is surrounded by the Osprey (B.F.) loam series. The terrain is hilly with good drainage potential.

The soil itself is medium to coarse in texture and lies on a coarse stony till in which rocky outcrops are prevalent.

The northern shore of the lake is mainly of a light to moderate slope. Moderate tree cover of both deciduous and coniferous types is present except for the northeast side where it is denser and predominantly coniferous. Soil depths average approximately 2 feet. The eastern side has a light slope with an average of 1 foot of soil. Forestation is mixed and dense. The area surrounding the north shore of Crowe River Bay is swampy. The south shore of the bay slopes gently with less than 1 foot of soil and numerous rocky outcrops. Medium mixed forest surrounds the bay. South of the bay a lightly sloping, moderately treed shoreline exists with varying soil depths of 6 inches to 3 feet. The shore is sprinkled with rocky outcrops.

The south bay shore consists of lowland and swamp with muck type soil of 6 inches to 1 foot and light mixed tree development, whereas, light soil cover, rocky outcrops and moderate to heavy mixed forest prevail on the lightly sloping south-western shore. In the area surrounding North River Bay, swampy land is prevalent with heavy brush and a medium density of deciduous trees. North of this, there is steeply sloping land with less than 1 foot of soil, plentiful rock and heavy deciduous forestation.

Belmont Lake has a surface area of 7.7 square kilometers (3 square miles) and a shoreline length of 31.9 kilometers (19.8 miles) including 6.8 kilometers (4.2 miles) of island shoreline. The lake has a maximum depth of 18 meters (60 feet) and a mean depth of 9 meters (30 feet).

Belmont Lake is located in the Crowe River Drainage Basin which is part of the greater Trent River Drainage Basin. The immediate watershed of the lake is 35 square kilometers (13.5 square miles) excluding the area drained by the Crowe River inflow which enters at the north end of Belmont Lake. The Crowe River's head waters stem from Paudash Lake. From there, the river drains many small streams and lakes including Chandos, Wollaston and Cordova before it enters the north end of Belmont Lake. The other inlet to the lake is the North River whose head waters originate in Kasshabog Lake, drain through Round Lake and enter Belmont Lake on its west shore.

The sole outlet of the lake is the Crowe River which flows out of the mideast shore towards Crowe Lake.

Water Usage

Most of the cottagers use the lake as their source of domestic water supply. It is used for recreational purposes such as boating, fishing, water skiing and swimming, as well as for winter sports. The lake offers a sport fishery of maskinonge, smallmouth bass, pickeral and speckled trout.

At the present time there are no direct discharges of raw or treated wastes into Belmont Lake from municipal or individual sewage treatment facilities. The area residents are provided with two municipal solid waste disposal sites located within two miles of the lake. The disposal site on Lot 7, Concession 9, Township of

Belmont appears to be satisfactory and is not posing any pollution hazard to the lake. The second site is located on Lot 19, Concession 4, Township of Belmont and is scheduled to be closed.

Shoreline Development

The shoreline of Belmont Lake is generally well developed with the exception of the midwest shore. There are approximately 380 summer cottages on the lake. A trailer park is located at the south end of the lake and a marina is located on the east shore across from the south tip of Big Island (Figure I).

RESULTS AND DISCUSSION

Bacteriology

The quantities of bacteriological data necessitated statistical methods to summarize the results into a concise presentation without the inconsistency associated with manual interpretation. The methods used are based on the analysis of variance and Barlett's test of homogeneity by which stations on a lake can be grouped into areas with the same bacterial level. Areas or stations with only slight differences in bacterial concentration can be isolated. It was found on previous work that areas, or stations, with significantly higher bacterial numbers generally indicated a pollution input. Details of statistical methods and data are available on request.

Belmont Lake was well within the Ministry of the Environment Criteria for total body contact recreational use during the June, August and September surveys (MOE 1972). These criteria state: "Where ingestion is probable, recreational waters can be considered impaired when the coliform (TC), fecal coliform (FC), and/or

enterococcus (FS) geometric mean density exceeds 1000, 100 and/or 20 per 100 ml respectively...". (1)

During the June survey (Figure 3) the lake had an overall geometric mean of 123 TC/100 ml, with the exceptions of the area within the influence of the North River (Group B) and the area around the mouth of the Crowe River and Deer Bay (Groups C, D and E) and at points near moderately cottaged areas (Stations 6, 24, 28, 31, 32D and 33).

The fecal streptococcus concentrations in the lake were generally low with an overall mean of 4 FS/100 ml, with the exceptions of the outflow of the North River which affected Stations 14 and 16, and the Crowe River and Deer Bay area (Stations 20, 21, 22, and 23). The mouth of the North River (Station 14), had exceptionally high fecal streptococcus counts with a geometric mean of 50 FS/100 ml which exceeded the Ministry of the Environment recreational use criteria and indicated a source of contamination. The lake was homogeneous for fecal coliform showing a density of 2 FC/100 ml, during the June survey.

The total coliform counts during the August survey (Figure 4) were considerably lower than the June survey. A mean of 9 TC/100 ml was calculated for Belmont Lake (Group A) while the mouth of the North River (Station 14) and the mouth of the Crowe River (Station 20) had means of 103 TC/100 ml and 187 TC/100 ml respectively. Similarily, the fecal coliform concentrations were very low with a mean of 1 FC/100 ml for most of the lake while the mouth of the North River and the Crowe River had means of 5 FC/100 ml and 6 FC/100 ml, respectively. These fecal coliform counts at the two river mouths (Station 14 and 20) indicate a minor bacterial pollution input. Belmont Lake had a homogeneous distribution of fecal streptococcus with a mean of 5 FS/100 ml during the August survey.

(1) Guidelines and Criteria for Water Quality Management in Ontario, MOE, 1972

FIGURE 3 - DISTRIBUTION OF BACTERIA IN JUNE

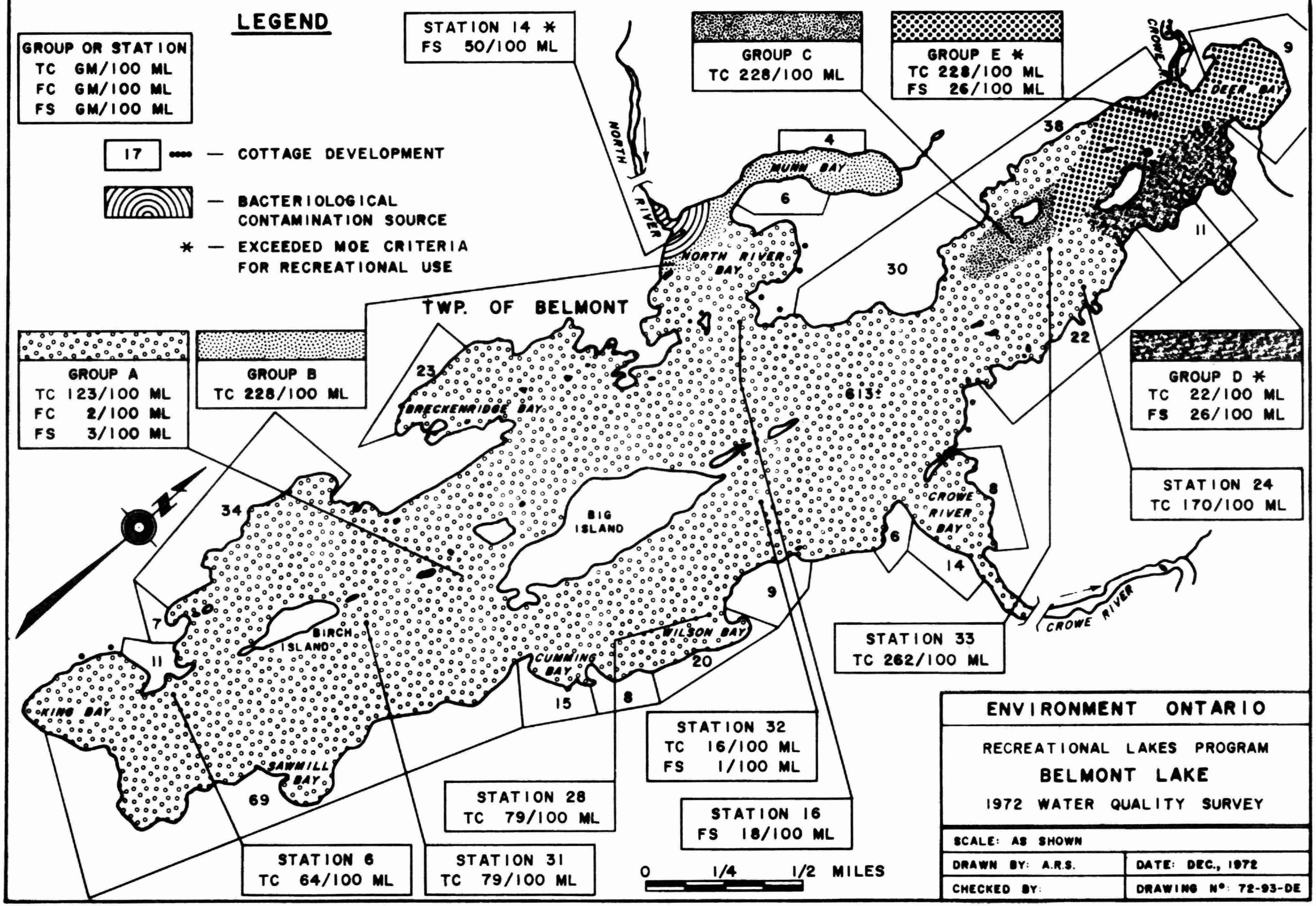
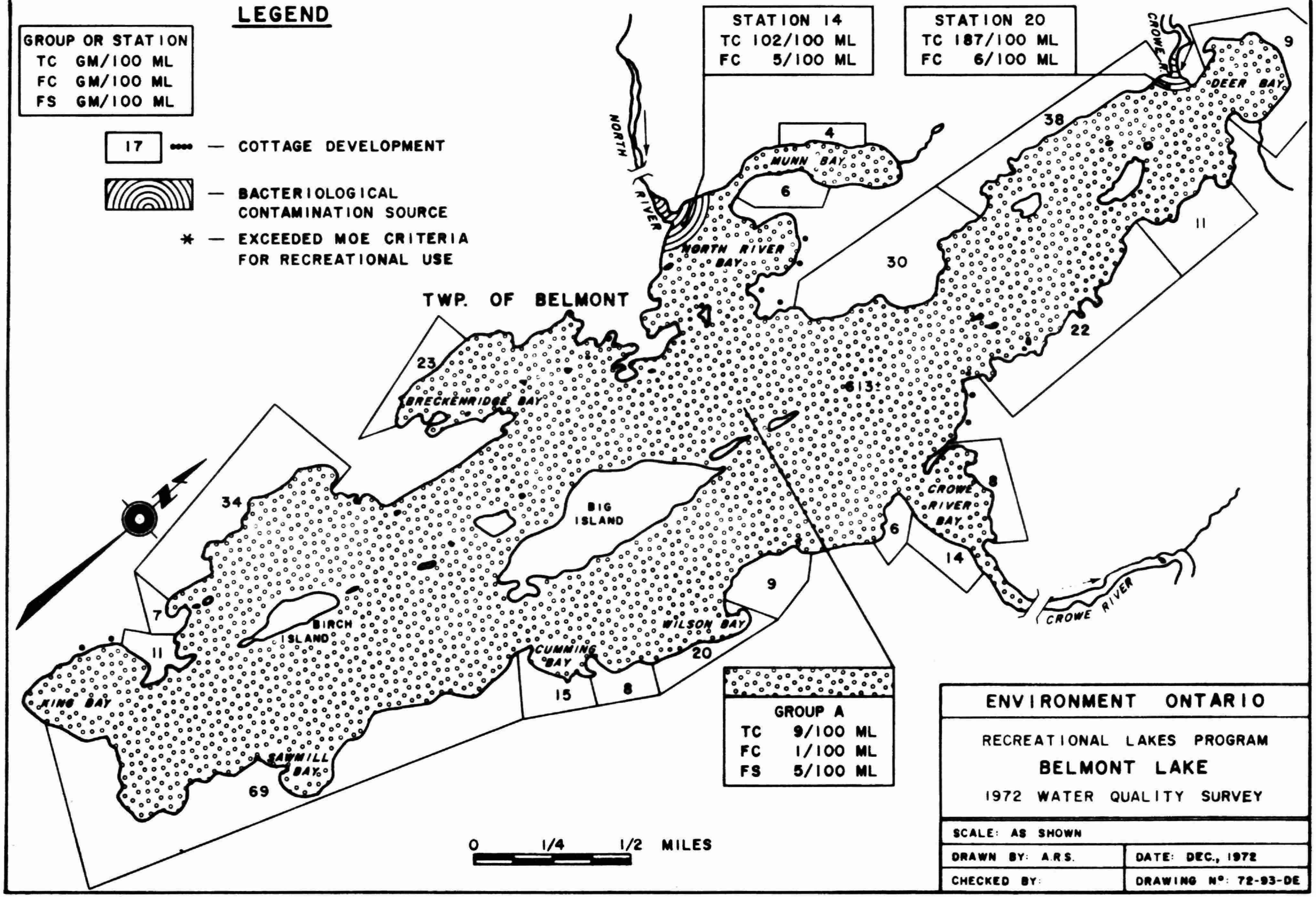


FIGURE 4 - DISTRIBUTION OF BACTERIA IN AUGUST



ENVIRONMENT ONTARIO

RECREATIONAL LAKES PROGRAM

BELMONT LAKE

1972 WATER QUALITY SURVEY

SCALE: AS SHOWN	
DRAWN BY: A.R.S.	DATE: DEC., 1972
CHECKED BY:	DRAWING Nº: 72-93-DE

During the September survey the lake was homogeneous for all three parameters, with means of: 108 TC/100 ml, 1 FC/100 ml, and 5 FS/100 ml, (Figure 5).

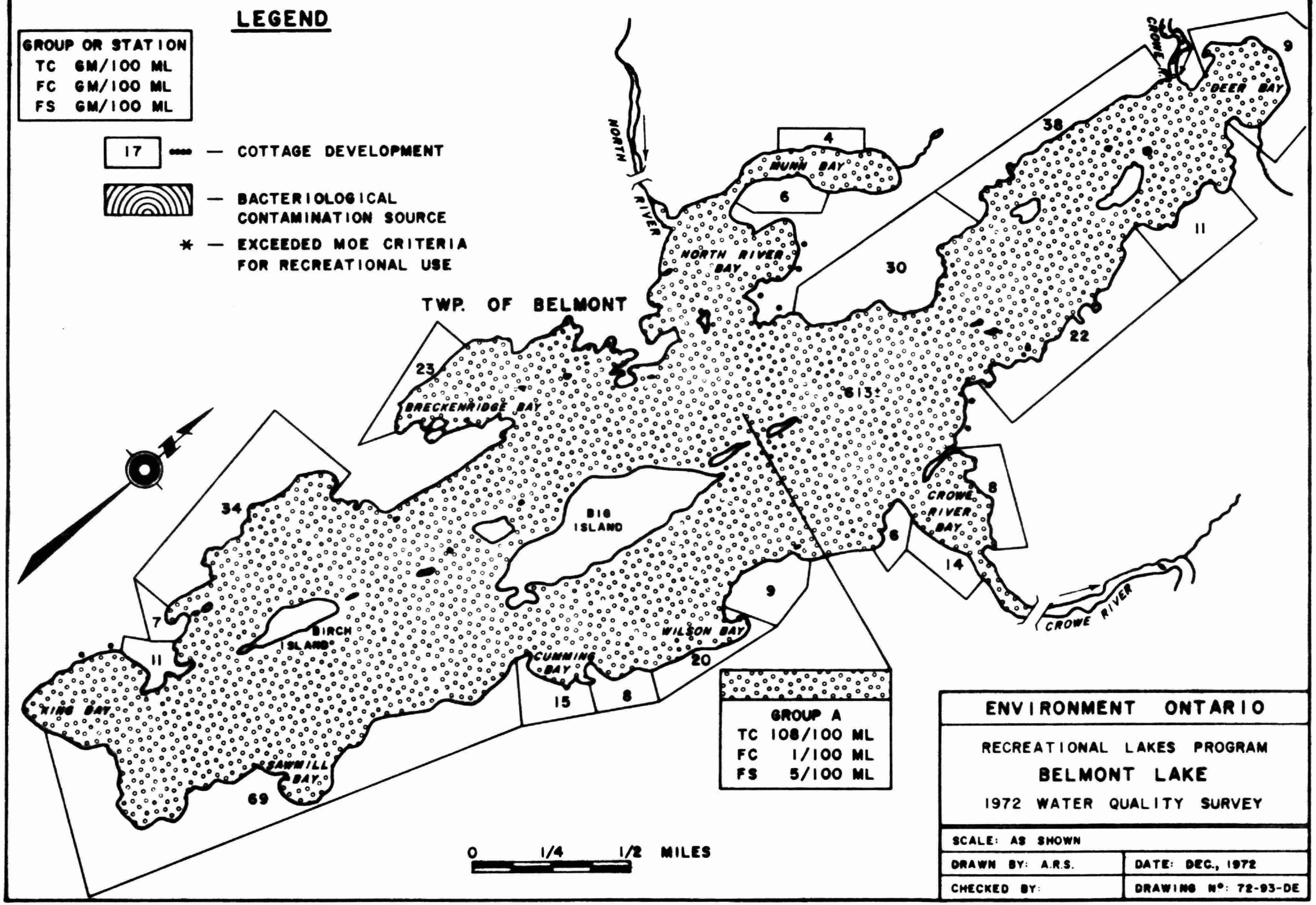
Runoff due to the rainfalls which occurred prior to and during the June survey are believed to be responsible for the elevated TC and FC counts at that time, which were considerably higher than in subsequent surveys. Rainfall preceding and during the August and September surveys was negligible. Rainfall, as recorded at Campbellford, the nearest Meteorological Station, and the effect of the associated runoff on TC counts is depicted in Figure 6. FC results showed similar variations. Presumably, the cumulative effect of the rains from June 20 to 23 carried large numbers of TC and FC from the shores into Belmont Lake. The counts obtained on June 25 are believed to have detected the residual effect of this increase as the TC bacteria were dying off. The most dramatic response is shown at Station 14 within the North River, where values having reached comparatively low levels on June 26, increased greatly following the June 26 and June 27 rainfalls, reaching a peak on June 28. The absence of rain on June 28 was followed by an almost instantaneous drop in bacteria by June 29. The mean of the TC responses at all sampling stations was more moderate than that at Station 14, while the graph of counts at Station 1 gives an example of the response at a station in the main body of Belmont Lake, remote from Station 14.

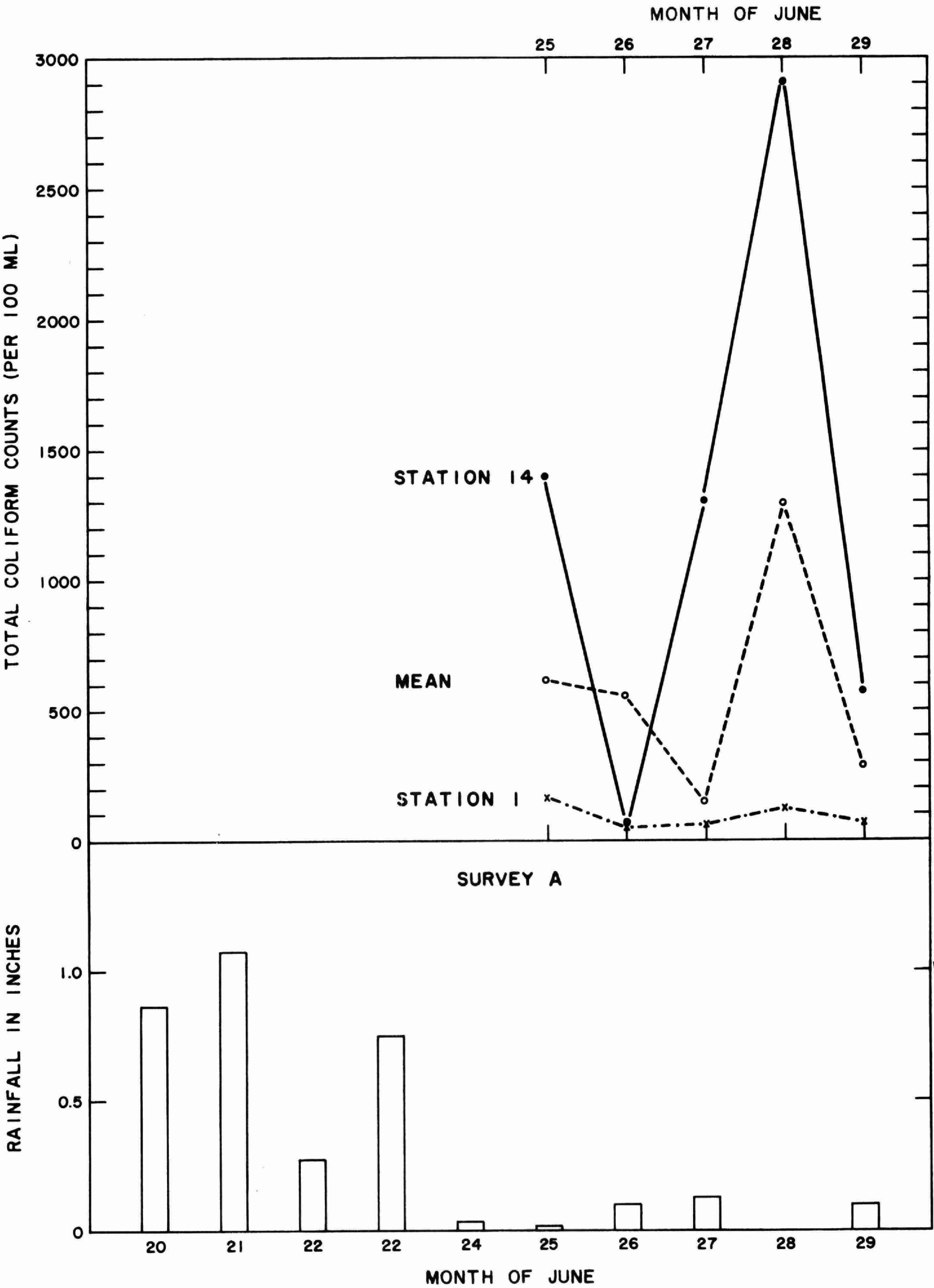
Standard Plate Count analysis was performed at Stations 32 and 33 on Belmont Lake to get an indication of the overall bacterial population. The geometric means for the three surveys ranged from 2400/100 ml to 10000/100 ml.

Secchi Disc and Chlorophyll a Correlation

Chlorophyll a levels were low throughout the entire body of Belmont Lake,

FIGURE 5 - DISTRIBUTION OF BACTERIA IN SEPTEMBER





BELMONT LAKE

FIGURE 6 - RAINFALL VS TOTAL COLIFORM COUNTS FROM JUNE 25-29, 1972

never exceeded 2.6 ug/l and averaged 1.3, indicating low fertility probably as a result of the low total phosphorus content, which ranged from 10 to 20 ug/l.

On a scale of lake enrichments as indicated by chlorophyll a concentrations and water transparency (Figure 7), Belmont Lake is similar to Balsam Lake and Cameron Lake, two relatively clear water lakes and is far removed from such highly enriched waters as the Western Basin of Lake Erie, Lake Scugog and the Bay of Quinte.

Chemistry

The mineral chemistry of Belmont Lake was governed by that of the major inflow from the upper Crowe River. On any given survey, samples from this inlet, from the mid-lake, and from the outlet stations had similar hardness, alkalinity and conductivity values. At all these stations, at both surface and depth, a gradual increase was apparent from June to September. At Station 32, values obtained from bottom samples showed an accentuated increase from late August to mid-September.

Samples collected at Station 14, at the North River inlet were consistently different from the above stations, with a somewhat higher mineral content which rose and then fell, between the June and September surveys. With its smaller watershed, the North River would be expected to show greater variability than the Crowe River.

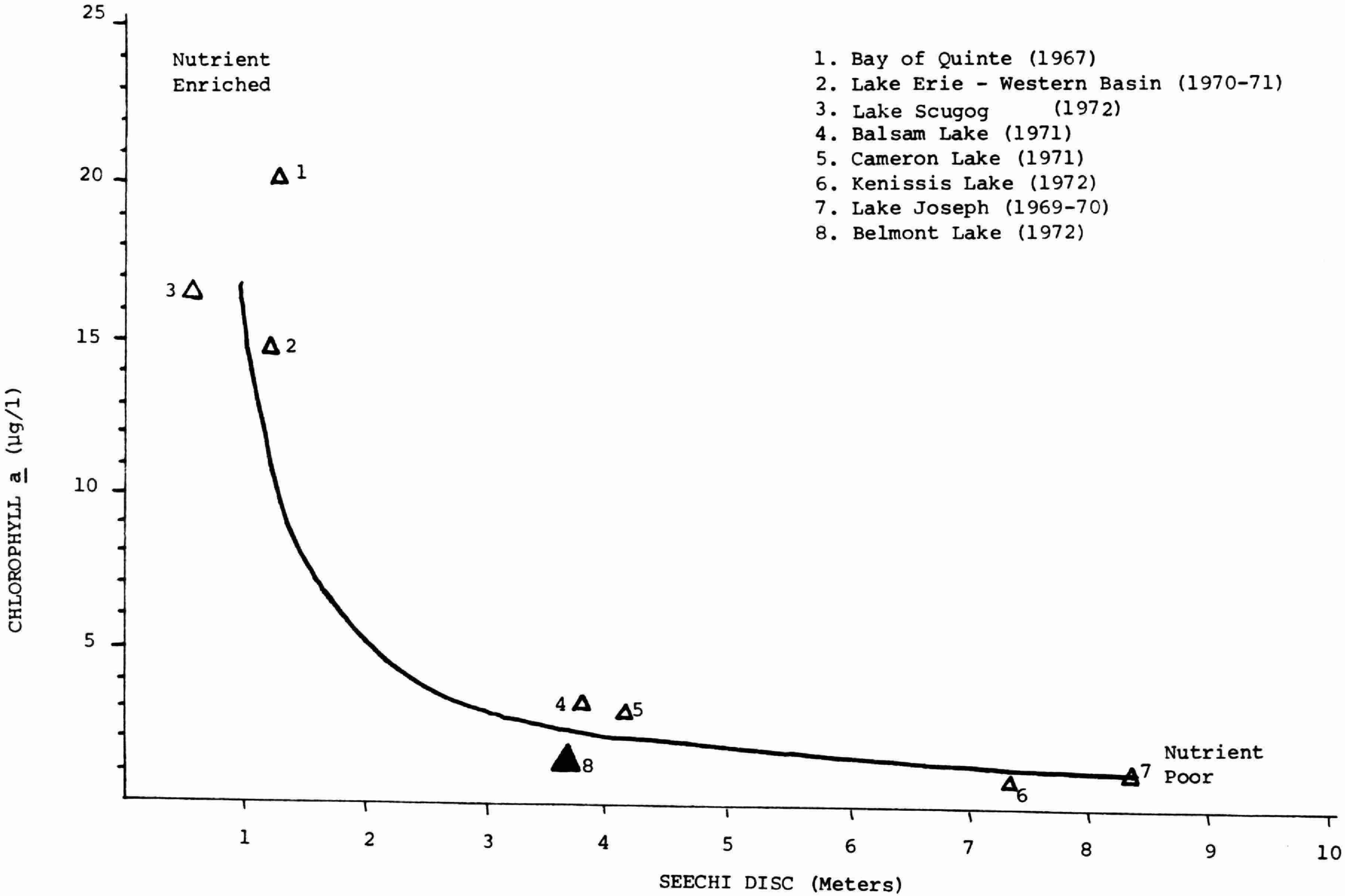


Figure 7: The mean of chlorophyll a and Secchi disc measurements in Belmont Lake relative to a curve describing the chlorophyll a - Secchi disc relationship in many Ontario lakes. Seven other well known lakes are included for comparison with Belmont Lake.

	Hardness as $CaCO_3$ mg/l	Alkalinity as $CaCO_3$ mg/l	Conductivity umhos/cm^3 mg/l
Average Values June	72	53	142
Average Values September	80	61	155
Station 32 Bottom, September	85	67	162
Station 14			
June	100	80	174
August	105	90	185
September	80	65	165

Chloride values were low, averaging 4 mg/l at all sampling points including the inlet from the North River, and showed little variation.

Iron values were low (0.05 to 0.20 mg/l) at all sampling points throughout the entire survey, with the exception of the bottom water at Station 32, where values ranged from 0.45 to 0.95 mg/l.

Values of pH measured at the mid-lake stations were found to decrease with depth. Calculated carbon dioxide values increased with depth, confirming that the process of bacterial decomposition of organic matter was occurring. Conditions of temperature stratification retard the escape of the carbon dioxide formed from the dissolved oxygen by this process.

Stations 31, 32, 33 June and August	1 Meter Deep	7-9 Meters Deep	16-17 Meters Deep
pH Range	7.8-7.4	7.5-7.2	7.1-7.0
CO_2 mg/l Range	2.0-4.4	6.0-6.7	9.1-10.3

Profile graphs (Figures 8 and 9) show temperature and dissolved oxygen stratification at Stations 32 and 33 from the start to the end of the study.

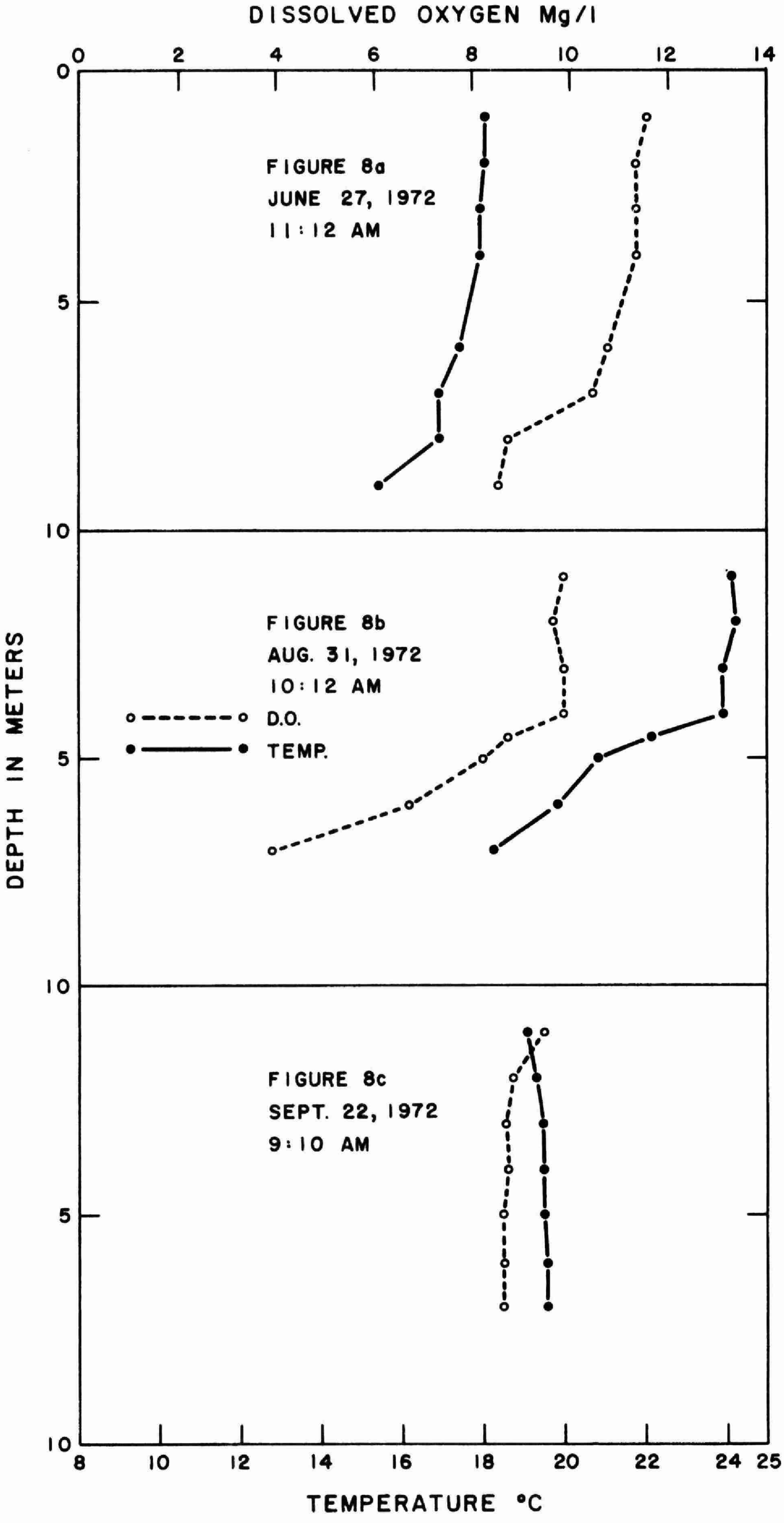
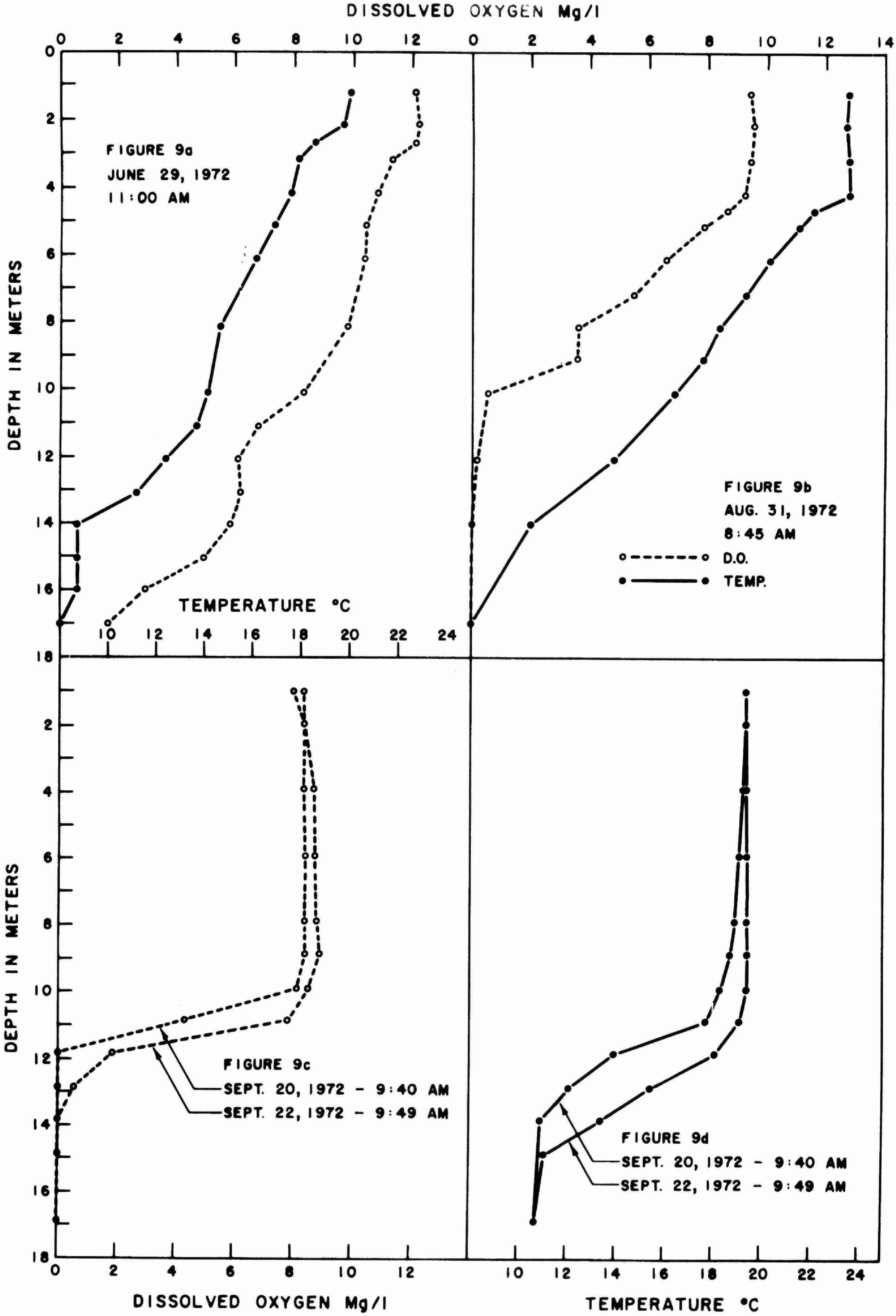


FIGURE 8 - DISSOLVED OXYGEN AND TEMPERATURE PROFILES AT STATION 33 BELMONT LAKE



BELMONT LAKE

FIGURE 9 - DISSOLVED OXYGEN AND TEMPERATURE PROFILES AT STATION 32

A sequential pattern is present in the graphs, indicating that there was a gradual depletion of dissolved oxygen (D.O.) during the 1972 survey, which was most critical in the deepest water in the lake (Station 32 - Figures 9a, b, c and d).

Stations 31 and 33, where the depth was moderate, showed similar patterns of D.O. depletion, pH reduction, and mineral increase during the period from June 25 to August 31. At both these stations the fall overturn (see section A-7 for an explanation) had occurred prior to September 19 and mixing had raised the dissolved oxygen level in these moderately deep bottom waters to that of the surface. In the deepest waters at Station 32, the deoxygenating effect was more pronounced and more persistant. Substantial D.O. depletions were evident even in June, bottom carbon dioxide values were higher, and pH was lower, than in the shallower bottom depths at Stations 31 and 33. By late August, four meters of the bottom water at Station 32 were devoid of oxygen, and this had increased to six meters by September 19. In addition, during the summer, a process of denitrification was evident (in this case, conversion of nitrate to ammonia) but only in these deep waters.

Station 32 16-17 Meters depth	June 25	June 29	Aug 27	Aug 31	Sept 19	Sept 23
Nitrate-N, ug/l	180	210	40	30	10	10
Ammonia-N, ug/l	50	30	170	170	280	180

Organic nitrogen (Total Kjeldahl minus ammonia nitrogen) remained relatively constant during this period and nitrite showed only a small peak in late August, rising from 4-7 to 12-[illegible] ; then falling again to 6 ug/l by late September.

Despite this cumulative evidence of a sustained oxygen lack, there was no indication that phosphorus was being recycled by anaerobic release from the bottom sediments at Station 32. There were no increases in phosphorus, nitrogen or iron in these deep waters with time, and no evidence of any ammonia increase beyond that produced from nitrate. In fact, there was some indication that iron decreased slightly, and total phosphorus levels declined from 44 to 20 ug/l in the deepest water by mid-September. There was no evidence of sulphide generation.

It would appear, therefore, that the factors causing deoxygenation were not severe, and did not, during the summer of 1972, include any substantial amount of decomposing algae, accumulated by settling to the bottom. Rather it could be surmised that a moderate organic content is present, originating mainly from the surrounding watersheds, which was sufficient through bacterial decomposition to cause complete deoxygenation and denitrification in the deepest layers of water, together with some mineral regeneration, but which was not so appreciable as to cause sulphide generation, or iron or nutrient recycling in these deep waters, nor to produce any more than moderate, temporary oxygen depletions in the less deep portions of Belmont Lake. In September, a rapid rate of oxygen recovery in the deep water at Station 32 is shown (Figures 9c and d). Perceptible migration of increased temperature and increased dissolved oxygen toward the bottom is evident in the two days between September 20 and 22. This would indicate that, within a short period following as further mixing occurred, the pool of oxygen deficiency even in the deepest portion of the lake would have been eliminated by the completion of the fall overturn.

It should be noted, however, that four to six meters of the deepest water was rendered uninhabitable for fish for a period of at least one month, probably longer. Discharges of organic wastes, or of nutrients which could sponsor additional algal and aquatic plant growth, and thereby additional decomposition of such material once it settled to the bottom, are likely to accentuate the severity and extent of the oxygen depletion in the deep water layers of Belmont Lake.

INFORMATION OF GENERAL INTEREST TO COTTAGERS
MICROBIOLOGY OF WATER

For the sake of simplicity, the microorganisms in water can be divided into two groups: the bacteria that thrive in the lake environment and make up the natural bacterial flora; and the disease causing microorganisms, called pathogens, that have acquired the capacity to infect human tissues.

The "pathogens" are generally introduced to the aquatic environment by raw or inadequately treated sewage, although a few are found naturally in the soil. The presence of these bacteria do not change the appearance of the water but pose an immediate public health hazard if the water is used for drinking or swimming. The health hazard does not necessarily mean that the water user will contract serious waterborn infections such as typhoid fever, polio or hepatitis but he may catch lesser infections of gastroenterities (sometimes called stomach flu), dysentery or diarrhea. Included in these minor afflictions are eye, ear and throat infections that swimmers encounter every year and the more insidious but seldom diagnosed, subclinical infections usually associated with several water born viruses. These virus infections leave a person not feeling well enough to enjoy holidaying although not bedridden. This type of microbial pollution can be remedied by preventing wastes from reaching the lake and water quality will return to satisfactory conditions within a relatively short time (approximately 1 year) since disease causing bacteria usually do not thrive in an aquatic environment.

The rest of the bacteria live and thrive within the lake environment. These organisms are the instruments of biodegradation. Any organic matter in the lake will be used as food by these organisms and will be used as food

by these organisms and will give rise, in turn, to subsequent increases in their numbers. Natural organic matter as well as that from sewage, kitchen wastes, oil and gasoline are readily attached by these lake bacteria. Unfortunately, biodegradation of the organic wastes by organisms uses correspondingly large amount of the dissolved oxygen. If the organic matter content of the lake gets high enough, these bacteria will deplete the dissolved oxygen supply in the bottom waters and threaten the survival of many deep water fish species.

The standard plate count (SPC) populations given in the text supply an indication of the number of these bacteria in the lake.

RAINFALL AND BACTERIA

The "Rainfall Effect" referred to in the text, relates to a phenomena that has been documented in previous surveys of the Recreational Lakes. Heavy precipitation has been shown to flush the land area arrund the lake and the subsequent runoff will carry available contaminants including sewage organisms as well as natural soil bacteria with it into the water.

Total coliforms, fecal coliforms and fecal streptococci, as well as other bacteria and viruses which inhabit human waste disposal systems can be washed into the lake. In Precambrian areas where there is inadequate soil cover and in fractured limestone areas where fissures in the rocks provide access to the lake, this phenomenon is particularly evident.

Melting snow provides the same transportation function for bacteria, especially in an agricultural area where manure spreading is carried out in the winter on top of the snow.

Previous data from sampling points situated 50 to 100 feet from shore indicate that contamination from shore generally shows up within 12 to 48 hours after a heavy rainfall.

WATER TREATMENT

Lake and river water is open to contamination by man, animals and birds (all of which can be carriers of disease); consequently, NO SURFACE WATER MAY BE CONSIDERED SAFE FOR HUMAN CONSUMPTION without prior treatment, including disinfection. Disinfection is especially critical if coliforms have been shown to be present.

Disinfection can be achieved by:

(a) Boiling

B oil the water for a minimum of five minutes to destroy the disease causing organisms.

(b) Chlorination Using a Household Bleach Containing 4 to 5.1/4% Available Chlorine

Eight drops of a household bleach solution should be mixed with one gallon of water and allowed to stand for 15 minutes before drinking.

(c) Continuous Chlorination

For continuous water disinfection, a small domestic hypochlorinator (sometime coupled with activated charcoal filters) can be obtained from a local plumber or water equipment supplier.

(d) Well Water Treatment

Well water can be disinfected using a household bleach (assuming

strength at 5% available chlorine) if the depth of water and diameter of the well are known.

CHLORINE BLEACH
per 10 ft depth of water

Diameter of Well Casing In Inches	One to Ten Coliforms	More than Ten Coliforms
4	.5 oz	1 oz.
6	1 oz.	2 oz.
8	2 oz.	4 oz.
12	4 oz.	8 oz.
16	7 oz.	14 oz.
20	11 oz.	22 oz.
24	16 oz.	31 oz.
30	25 oz.	49 oz.
36	35 oz.	70 oz.

Allow about six hours of contact time before using the water.

Another bacteriological sample should be taken after one week of use.

Water Sources (spring, lake, well, etc.) should be inspected for possible contamination routes (surface soil, runoff following rain and seepage from domestic waste disposal sites). Attempts at disinfecting the water alone without removing the source of contamination will not supply bacteriologically safe water on a continuing basis.

There are several types of low cost filters (ceramic, paper, carbon, diatomaceous earth sometimes impregnated with silver, etc.) that can be easily installed on taps or in water lines. These may be useful to remove particles if water is periodically turbid and are usually very successful. Filters, however, do not disinfect water but may reduce bacterial numbers. For safety, chlorination of filtered water is recommended.

SEPTIC TANK INSTALLATIONS

In Ontario, provincial law requires that you obtain permission in writing to install a septic tank system. Permission can be obtained from the local Medical Officer of Health or in some instances from the Regional Engineer of the Ministry of the Environment. Any other pertinent information such as sizes, types and location of septic tanks and tile fields can also be obtained from the same authority.

(i) General Guidelines

A septic tank should not be closer than:

-50 feet to any well, lake, stream or pond.
-5 feet to any building.
-10 feet to any property boundary

The tile field should not be closer than:

-100 feet to the nearest dug well.
-50 feet to a drilled well which has a casing to 25 feet below ground.
-25 feet to a building
-10 feet to a property boundary.
-50 feet to any lake, stream or pond.

The ideal location for a tile field is in a well drained, sandy loam soil remote from any wells or other drinking water sources. For the tile field to work satisfactorily, there should be at least 3 feet of soil between the bottom of the weeping tile trenches and the top of the ground water table or bedrock.

DYE TESTING OF SEPTIC TANK SYSTEMS

There is considerable interest among cottage owners to dye test their sewage systems, however, several problems are associated with dye testing. Dye would not be visible to the eye from a system that has a fairly direct

connection to the lake. Thus, if a cottager dye-tested his system and no dye was visible in the lake, he would assume that his system is satisfactory, which might not be the case. A low concentration of dye is not visible and therefore expensive equipment such as a fluorometer is required. Only qualified people with adequate equipment are capable of assessing a sewage system by using dye. In any case, it is likely that some of the water from a septic tank will eventually reach the lake. The important question is whether all contaminants including nutrients have been removed before it reaches the lake. To answer this question special knowledge of the system, soil depth and composition, underground geology of the region and the shape and flow of the shifting water table are required. Therefore, we recommend that this type of study should be performed only by qualified professionals.

BOATING REGULATION

In order to help protect the lakes and rivers of Ontario from pollution it is required by law that sewage (including garbage) from all pleasure craft, including houseboats must be retained in equipment of a type approved by the Ministry of the Environment. Equipment which will be approved by the Ministry of the Environment includes (1) retention devices with or without circulation which retain all toilet wastes for disposal ashore, and (2) incinerating devices which reduce all sewage to ash.

To be approved, equipment shall:

1. be non-portable,
2. be constructed of structurally sound material,
3. have adequate capacity for expected use
4. be properly installed,

5. in the case of storage devices, be equipped with the necessary pipes and fittings conveniently located for pump-out by shore-based facilities (although not specified, a pump-out deck fitting with 1.1/2 inch National Pipe Thread is commonly used).

An Ontario regulation requires that marinas and yacht clubs provide or arrange pump-out service for the customers and members who have toilet-equipped boats. In addition, all marinas and yacht clubs must provide litter containers that can be conveniently used by occupants of pleasure boats.

The following "Tips" may be of assistance to you in regards to boating:

1. Motors should be in good mechanical condition and properly tuned.

2. When a tank for outboard motor testing is used, the contents should not be emptied into the water.

3. Fuel hoses must be in good condition and all connections tight.

4. If the bilge is cleaned prior to the boating season, the waste material must not be dumped into the water.

5. Fuel tanks must not be overfilled and space must be left for expansion if the fuel warms up.

6. Vent pipes should not be obstructed and fuel needs to be dispensed at a correct rate to prevent "blow-back".

7. Empty oil cans must be deposited in a leak-proof receptacle.

ICE-ORIENTED RECREATIONAL ACTIVITIES

The Ministry of the Environment is presently preparing regulations to control pollution from ice-oriented recreational activities. In past years, there has been indiscrimate dumping of garbage and sewage on the ice. The bottoms of fish huts have been left on the ice and become a navigational hazard to boaters in the spring. Broken glass has been left on the ice only to become

injurious to swimmers. With the anticipated introduction of the regulations, many of these abuses will become illegal

EUTROPHICATION OR EXCESSIVE FERTILIZATION AND LAKE PROCESSES

The changes in water quality brought about by excessive inputs of nutrients to lakes are usually evidenced by excessive growths of algae and aquatic plants.

Aquatic plants and algae are important in maintaining a balanced aquatic environment. They provide food and a suitable environment for the growth of aquatic invertebrate organisms which serve as food for fish. Shade from large aquatic plants helps to keep the lower water cool which is essential to certain species of fish and also provide protection for young game and forage fish. Numerous aquatic plants are utilized for food and/or protection by many species of waterfowl. However, too much growth creates an imbalance in the natural plant and animal community particularly with respect to oxygen conditions, and some desirable forms of life such as sport fish are eliminated and unsightly algae scums can form. The lake will not be "dead" but rather abound with life which unfortunately is not considered aesthetically pleasing. This change to poor water quality becomes apparent after a period of years in which extra nutrients are added to the lake and a return to the natural state may also take a number of years after the nutrient inputs are stopped. Changes in water quality with depth are a very important characteristic of a lake. Water temperatures are uniform throughout the lake in the early spring and winds generally keep the entire volume well mixed. Shallow lakes may remain well mixed all summer so that water quality will be the same throughout. On the other hand, in deep lakes, the surface waters

warm up during late spring and early summer and float on the cooler more dense water below. The difference in density offers a resistance to mixing by wind action and many lakes do not become fully mixed again until the surface waters cool down in the fall. The bottom water receives no oxygen from the atmosphere during this unmixed period and the dissolved oxygen supply may be all used up by bacteria as they decompose organic matter. Cold water fish, such as trout, will have to move to the warm surface waters to get oxygen and because of the high water temperatures they will not thrive, so that the species will probably die out (see Figure next page).

Low oxygen conditions in the bottom waters are not necessarily an indication of pollution but excessive aquatic plant and algae growth and subsequent decomposition can aggravate the condition and in some cases can result in zero oxygen levels in lakes which had previously held some oxygen in the bottom waters all summer. Although plant nutrients normally accumulate in the bottom waters of lakes, they do so to a much greater extent if there is no oxygen present. These nutrients become available for algae in the surface waters when the lake mixes in the fall and dense algae growths can result. Consequently, lakes which have no oxygen in the bottom water during the summer are more prone to having algae problems and are more vulnerable to nutrient inputs than lakes which retain some oxygen.

CONTROL OF AQUATIC PLANTS AND ALGAE

Usually aquatic weed growths are heaviest in shallow shoreline areas where adequate light and nutrient conditions prevail.

Extensive aquatic plant and algal growths sometimes interfere with

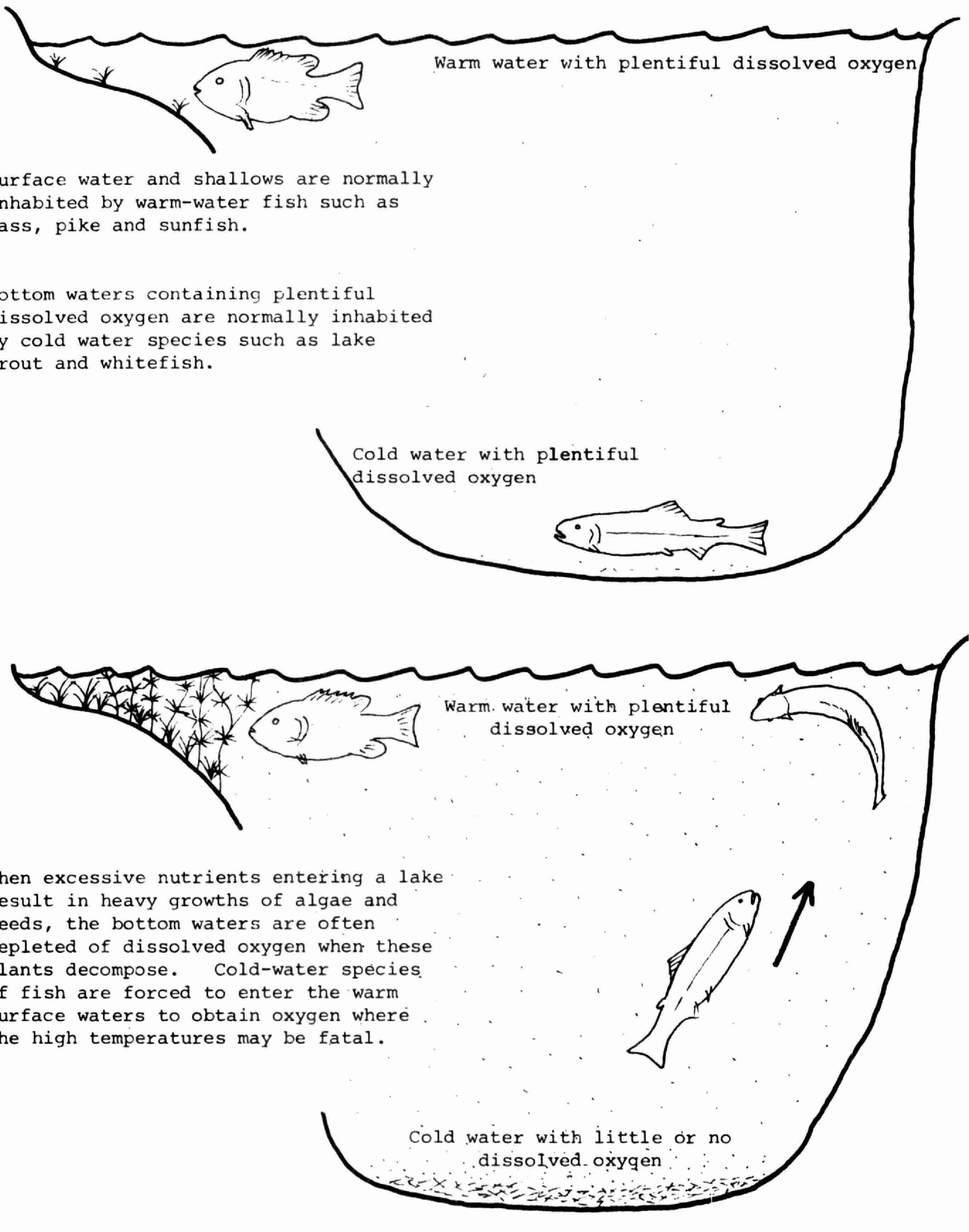


FIGURE A-1: DECOMPOSITION OF PLANT MATTER AT THE LAKE BOTTOM CAN LEAD TO DEATH OF DEEP-WATER FISH SPECIES.

boating and swimming and ultimately diminish shoreline property values.

Control of aquatic plants may be achieved by either chemical or mechanical means. Chemical methods of control are currently the most practical, considering the ease with which they are applied. However, the herbicides and algicides currently available generally provide control for only a single season. It is important to ensure that an algicide or herbicide which kills the plants causing the nuisance, does not affect fish or other aquatic life and should be reasonable in cost. At the present time, there is no one chemical which will adequately control all species of algae and other aquatic plants. Chemical control in the province is regulated by the Ministry of the Environment and a permit must be granted prior to any operation. Simple raking and chain dragging operations to control submergent species have been successfully employed in a number of situations; however, the plants soon re-establish themselves. Removal of weeds by underwater mowing techniques is certainly the most attractive method of control and is currently being evaluated in Chemung Lake near Peterborough. Guidelines and summaries of control methods, and applications for permits are available from the Biology Section, Water Quality Branch, Ministry of the Environment, Box 213, Rexdale, Ontario.

PHOSPHORUS AND DETERGENTS

Scientists have recognized that phosphorus is the key nutrient in stimulating algal and plant growth in lakes and streams.

In the past years, approximately 50% of the phosphorus contributed by municipal sewage was added by detergents. Federal regulations reduced

the phosphate content as P_2O_5 in laundry detergents from approximately 50% to 20% on August 1, 1970 and to 5% on January 1, 1973.

It should be recognized that automatic dishwashing compounds were not subject to the recently approved government regulations and that surprisingly high numbers of automatic dishwashers are present in resort areas (a questionnaire indicated that about 30% of the cottages in the Muskoka Lakes have automatic dishwashers). Cottagers utilizing such conveniences may be contributing significant amounts of phosphorus to recreational lakes. Indeed, in most of Ontario's vacation land, the source of domestic water is soft enough to allow the exclusive use of liquid dishwashing compounds, soap and soap-flakes.

ONTARIO'S PHOSPHORUS REMOVAL PROGRAM

By 1975, the Government of Ontario expects to have controls in operation at more than 200 municipal wastewater treatment plants across the province serving some 4.7 million persons. This represents about 90% of the population serviced with sewers. The program is in response to the International Joint Commission recommendations as embodied in the Great Lakes Water Quality Agreement and studies carried out by the Ministry of the Environment on inland recreational waters which showed phosphorus to be a major factor influencing eutrophication. The program makes provision for nutrient control in the Upper and Lower Great Lakes, the Ottawa River system and in prime recreational waters where the need is demonstrated or where emphasis is placed upon prevention of localized eutrophication.

Phosphorus removal facilities must be operational at wastewater treatment plants by December 31, 1973, in the most critically affected areas

of the province, including all of the plants in the Lake Erie drainage basin and the inland recreational areas. The operational date for plants discharging to waters deemed to be in less critical condition which includes plants larger than one million gallons per day (1 mgd) discharging to Lake Ontario and to the Ottawa River system, is December 31, 1975. The 1973 phase of the program will involve 156 plants of which 85 are in the Lake Erie basin and another 30 in the Lake Huron drainage basin. The capacities of these plants range from 0.04 to 24.0 mgd, serving an estimated population of 1,600,000 persons. The 1975 phase will bring into operation another 57 plants ranging in size from 0.3 to 180 mgd serving an additional 3,100,000 persons. Treatment facilities utilizing the Lower Great Lakes must meet effluent guidelines of less than 1.0 milligrams per litre of total phosphorus in their final effluent. Facilities utilizing the Upper Great Lakes, the Ottawa River Basin and certain areas of Georgian Bay where needs have been demonstrated must remove at least 80% of the phosphorus reaching their sewage treatment plants.

CONTROL OF BITING INSECTS

Mosquitoes and blackflies often interfere with the enjoyment of recreational facilities at the lake-side vacation property. Pesticidal spraying or fogging in the vicinity of cottages produces extemely temporary benefits and usually do not justify the hazard involved in contaminating the nearby water. Eradication of biting fly populations is not possible under any circumstances and significant control is rarely achieved in the absence of large-scale abatement programmes involving substantial funds and trained personnel. Limited use of approved

larvicides in small areas of swamp or in rain pools close to residences on private property may be undertaken by individual landowners, but permits are necessary wherever treated waters may contaminate adjacent streams or lakes. The use of repellents and light traps is encouraged as are attempts to reduce mosquito larval habitat by improving land drainage. Applications for permits to apply insecticides as well as technical advice can be obtained from the Biology Section, Water Quality Branch of the Ministry of the Environment, Box 213, Rexdale, Ontario.

ONTARIO
MINISTRY OF THE ENVIRONMENT

Report on Water Quality in Belmont Lake - Recreational Lakes Program, 1973
TERMINAL STREAM: TRENT R.

DATE	ISSUED TO

DATE	ISSUED TO

Date Due
